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EP-A- 0 228 743
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Description

This invention relates to a low cost flat array antenna particularly, but not exclusively, for receiving T.V. transmissions from a geostationary satellite.

U.S. patent 4,486,758 discloses a flat array triplate antenna for coupling circularly polarised radiation to a plurality of feed lines by way of a planar array of such elements each having a pair of orthogonally disposed dipoles, the dipole array being positioned between conductive sheets each having corresponding arrays of apertures. The dipole array and associated transmission strip lines are spaced from the conductive sheets by layers of dielectric material. The dipoles are formed one from each pair on one surface of a dielectric sheet and the other one of the pair on the opposite surface of the sheet. The respective strip line networks are also formed on the respective opposite surfaces of the sheet. In one embodiment of this prior art antenna a third unapertured conductive sheet is spaced from one of the apertured conductive sheets to act as a reflective surface.

The antenna is fabricated in accordance with conventional rigid printed circuit techniques, which will cause fairly high losses to be encountered, and which care not conducive with low cost high volume array production.

European patent application No. 0 252 779A proposes the use of metal plates which are shaped by pressing and stamping in order to form radiating slots and to emboss spacing abutments on the plate surfaces facing the dielectric sheet carrying printed conductors and terminations. Application EP 0 252 779A states that the use of embossed spacing abutments obviates the need for expensive solid dielectric material to space the conductive sheets from the dielectric sheet carrying the printed conductors. However, we have found that embossing of metal plates to form accurate spacing abutments is a complex and costly procedure to support the stripline. Such a procedure does not lend itself to low cost array production techniques which require that all manufacturing operations are rapid and simple as possible whilst providing a product of adequate quality.

Specification No. EP-A-312989 describes an antenna structure which is sandwiched between top and bottom plates and is supported by protrusions extending from those plates. Specification No. EP-A-228 743 describes a structure in which an antenna array is mounted on stands extending from support members. Specification No. DE-A-3243823 describes a peripheral sealing arrangement e.g. for a radome cover.

It is an object of the invention to produce a cheap antenna on a mass production basis and having a low loss.

According to the invention there is provided a flat antenna assembly, including a plastics base support structure having an array of first support pillars for engaging first openings in an antenna array mounted on the base support structure whereby to effect lateral alignment in the plane of the array, and a plastics radome cover having together with the base support structure a cooperative seal whereby to retain the cover on the base support so as to enclose the antenna array, characterised in that the base support structure has an array of second support pillars each adapted to receive a shouldered pin or screw engaging a corresponding second opening in the antenna array, and that each said pin or screw has a shank of a length such that, when that pin or screw is mounted on its respective second support pillar, the elements of the array are retained and are aligned in a direction normal to the plane of the antenna array.

In a preferred embodiment of the invention the pairs of orthogonal terminations are disposed in an orthogonal array and the orientations of each pair of terminations are at 45° to the perpendicular axes of the array.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a part sectional part schematic view of part of a flat array antenna according to the embodiment;

Fig. 2 is a perspective exploded view of the flat array antenna;

Fig. 3 is a part sectional view of the flat array antenna showing details of the assembly fixing arrangements;

Fig. 4 is a plan view of the triplate structure of the antenna;

Fig. 5 is a part sectional view illustrating the manner in which the radome cover is mounted and sealed to the antenna assembly; and

Fig. 6 is a detail of the plan view showing schematically the orientation of the orthogonal terminations.

The various views shown in the drawings are not dimensionally accurate and are for illustrative purposes only.

Referring to the drawings, the antenna comprises a suspended dielectric film 11 positioned between two metal plates 13, 15 by means of foam dielectric layers 17, 19. The dielectric film 11 has formed thereon, by conventional printed circuit techniques pairs of circuit terminations or "excitation probes" 21, 23 which are orthogonally positioned with respect to one another, and this printed film forms the flat stripline feed structure.

The metal plates 13, 15 are each provided with an array of apertures 25, 27 arranged in respective orthogonal arrays. The apertures 25 and 27 are fabricated in the flat metal plate 13, 15 by simple conventional metal stamping out techniques. By way of example, Applicants have found that it is practical to

stamp out an array of holes in flat aluminium sheet of thickness of only 0.5mm. Such flat sheets have sufficient rigidity when sandwiched with layers of foam dielectric material, such as expanded polyethylene, to support the suspended stripline formed on a thin polyester film.

The film 11 and the plates 13, 15 are arranged so that the apertures 25, the pairs of probes 21, 23 and the apertures 27 are aligned perpendicular to the plane of the dielectric film 11 and together provide an array of antenna elements. The probes of each pair are connected to each other by stripline sections (not shown) and all the stripline sections are connected to a common stripline feed structure (not shown) in accordance with known techniques to effect reception (or transmission) of circularly polarised radio frequency signals. Such connection techniques are known from, for example, U.S. patent No. 4,792,810.

Additionally the antenna may be provided with a third, generally unapertured metal plate 29 spaced from the metal plate 15 to act as a reflector plate.

The triplate structure and the reflector plate 37 are secured to a rigid base 30, in this embodiment made of a moulded plastics, by fixings, in this embodiment screws 31, 33 respectively engaging with blind bores in pillars 35, 37 respectively passing through corresponding holes in the file 11 and in the plates 13, 15 and 29. In addition there are shouldered pillars or dowels 39 which pass through close fitting holes in all the layers of the assembled structure to provide accurate lateral alignment of the apertures 25, 27 with the probes 21, 23. Note that the holes in the metal plates through which the pillars 35 pass are clearance holes to prevent distortion of the metal plates when the screws are tightened. Furthermore the screws 31 have shouldered spacer shank portions 31a of predetermined length so that when properly tightened they exert no undue compression on the triplate structure consisting of metal plates 13, 15, the suspended dielectric film 11 and supporting foam dielectric layers 17, 19, and determine the maximum spacing between the outer surfaces of the plates at each fixing location. The length of the shouldered portion 31a is such that when the plates 13, 15 and foam layers 17, 19 are of maximum thickness allowed by manufacturing tolerance, there is insignificant compression and distortion of the triplate structure. Likewise, when the thicknesses of 13, 15, 17 and 19 are the minimum allowable there will be insignificant slack in the holding of the triplate structure by the screws. The foam dielectric layers 17, 19 are unapertured except for the holes where the locating and securing pillars pass through. Thus the screws 31, shoulder 31a and pillars 35, together with the foamed dielectric layers 17 and 19 accurately control the spacing between the outer surfaces of the ground planes 13 and 15. The foam dielectric is soft and gently embraces the feed structure sufficient to prevent any periodic distortions near the fractional wavelength period mentioned above.

Applicants have noted that it is advantageous to have a diversity of orientations for the probe pairs 21, 23. In particular Applicants have determined that the performance of the antenna array is optimised when the alignments of the individual probes are at 45° to the axes of the columns and rows of the orthogonal array of antenna elements.

The common feed stripline structure referred to above (and not shown in the drawings) has an output termination which couples into a rectangular waveguide 41 the propagation axis of which is perpendicular to the plane of the triplate structure.

In order to reduce leakage losses at the edges of the metal plates the edges may be formed with lips (not shown) at right angle to the plane of the plates. Likewise the reflecting plate 29 may be formed with right angled lips 45.

The antenna assembly is protected against the environment by a plastics radome cover 43 secured to the plastics base support 30 via a peripheral seal. Fig. 5 shows the detail of a suitable seal between the radome and the base. For clarity the antenna components, i.e. the triplate structure and back reflector, have been omitted from Fig. 5. The radome cover 43 has a circumferential flange 51 terminating in an inwardly directed lip 52. Optionally a further, smaller flange 53 may be mounted on the inner surface of the radome cover 43 adjacent the flange 51 so as to define a circumferential channel 54. The base support 30 has a peripheral flange 55 and a further oppositely directed peripheral flange 56 defining a shoulder 57 therebetween.

When the structure is assembled, the radome cover 43 is urged against the base support 30 such that the flange 55 of the base support enters the channel 54 and the inwardly directed lip 52 of the radome cover engages the shoulder 57 whereby to retain the cover 43 in abutment with the base support 30 and provide a substantially water-tight seal at the joint therebetween. In some applications an adhesive or sealant may be applied to the joint between the cover and base support to ensure the integrity of the seal.

Advantageously the base support 30 has a breathe opening (not shown) whereby to allow drainage of any condensed moisture and to prevent a build up of intense pressure e.g. when the antenna is exposed to the sun.

The antenna may be assembled by the following sequence.

The back reflector is positioned in the base support 30 and is secured thereto by screws 33 engaging pillars 37. Next the triplate assembly is placed over the pillars 39 and the shanked screws 31 are inserted into the pillars 35. Finally the triplate structure is covered by the radome 43 by pressing the radome against the base support to engage the seal there-

between. As the pillars 39 and the shanked screws 31 provide accurate linearised positioning of the antenna components, the entire assembly can be effected rapidly and by relatively unskilled staff. This allows the antenna to be produced by low cost mass production techniques.

Claims

1. A flat antenna assembly, including a plastics base support structure (30) having an array of first support pillars (39) for engaging first openings in an antenna array (13,17,11,19,15) mounted on the base support structure whereby to effect lateral alignment in the plane of the array, and a plastics radome cover (43) having together with the base support structure a cooperative seal (52,55) whereby to retain the cover on the base support so as to enclose the antenna array, characterised in that the base support structure has an array of second support pillars (35) each adapted to receive a shouldered pin or screw (31) engaging a corresponding second opening in the antenna array, and that each said pin or screw has a shank (31a) of a length such that, when that pin or screw is mounted on its respective second support pillar, the elements of the array are retained and are aligned in a direction normal to the plane of the antenna array.

2. An antenna assembly as claimed in claim 1, characterised in that the antenna array is a triplate structure supported between a pair of ground planes (13,15).

3. An antenna assembly as claimed in claim 2, characterised in that the triplate feed is disposed on a thin dielectric substrate (11) which is maintained flat and parallel to the ground planes by a foam dielectric material (12, 19).

4. An antenna as claimed in claim 3, characterised in that the foam dielectric comprises on each side of said substrate a respective continuous foam dielectric sheet which is soft and gently embraces both the substrate and the respective ground plane.

5. An antenna assembly as claimed in any one of the preceding claims, characterised in that a plurality of third pillars (37) are provided on the base support structure whereby to support a back reflector (29) at a predetermined distance from the antenna array.

6. An antenna assembly as claimed in claim 5, characterised in that said back reflector is further supported on shoulders provided on said first and second pillars.

7. An antenna assembly as claimed in any one of the preceding claims, characterised in that said peripheral sealing means comprises inwardly directed lip adapted to engage a corresponding peripheral shoulder on the base support.

Patentansprüche

1. Flache Antennenbaugruppe mit einer aus Kunststoff bestehenden Grund-Tragstruktur (30), die eine Gruppe von ersten Stützpfosten (39) für den Eingriff in ersten Öffnungen in einer auf der Grund-Tragstruktur befestigten Gruppenantenne (13, 17, 11, 19, 15) zur Erzielung einer seitlichen Ausrichtung in der Ebene der Gruppenantenne aufweist, und mit einer aus Kunststoff bestehenden Schutzabdeckung (43), die zusammen mit der Grund-Tragstruktur eine zusammenwirkende Abdichtung (52, 55) aufweist, um auf diese Weise die Schutzabdeckung auf der Grund-Tragstruktur festzuhalten, um so die Gruppenantenne zu umschließen, dadurch gekennzeichnet, daß die Grund-Tragstruktur eine Gruppe von zweiten Stützpfosten (35) aufweist, die jeweils zur Aufnahme eines mit einer Schulter versehenen Stiftes oder einer Schraube (31) ausgebildet sind, der bzw. die in einer entsprechenden zweiten Öffnung in der Gruppenantenne in Eingriff steht, und daß alle Stifte oder Schrauben einen Schaft (31a) mit einer derartigen Länge aufweisen, daß, wenn der Stift oder die Schraube auf dem jeweiligen zweiten Stützpfosten befestigt ist, die Elemente der Gruppenantenne festgehalten und in einer Richtung senkrecht zur Ebene der Gruppenantenne ausgerichtet sind.

2. Antennenbaugruppe nach Anspruch 1, dadurch gekennzeichnet, daß die Gruppenantenne einer aus drei Platten bestehende Konstruktion ist, die zwischen zwei Masse-Ebenen (13, 15) gehaltert ist.

3. Antennenbaugruppe nach Anspruch 2, dadurch gekennzeichnet, daß die Drei-Platten-Speisung auf einem dünnen Isoliersubstrat (11) angeordnet ist, das durch ein Isolierschaummaterial (12, 19) eben und parallel zu den Masse-Ebenen gehalten wird.

4. Antenne nach Anspruch 3, dadurch gekennzeichnet, daß der Isolierschaum auf jeder Seite des Substrates eine jeweilige durchgehende Isolierschaumplatte umfaßt, die

weich ist und sowohl das Substrat als auch die jeweilige Masse-Ebene sanft umgreift.

5. Antennenbaugruppe nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, daß eine Vielzahl von dritten Stützpfosten (37) auf der Grund-Tragstruktur vorgesehen sind, um einen rückseitigen Reflektor (29) in einem vorgegebenen Abstand von der Gruppenantenne zu haltern.

6. Antennenbaugruppe nach Anspruch 5,
dadurch gekennzeichnet, daß der rückseitige Reflektor weiterhin auf Schultern gehaltert ist, die auf den ersten und zweiten Stützpfosten vorgesehen sind.

7. Antennenbaugruppe nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, daß die Umfangsdichtungseinrichtungen eine nach innen gerichtete Lippe umfassen, die zum Eingriff mit einer entsprechenden Umfangsschulter auf der Grund-Tragstruktur ausgebildet ist.

Revendications

1. Ensemble à antenne plate, comprenant une structure (30) de support de base de matière plastique ayant une matrice de premiers piliers (39) de support destinés à coopérer avec les premières ouvertures d'une matrice (13, 17, 11, 19, 15) d'antenne montée sur la structure de support de base de manière qu'un alignement latéral soit assuré dans le plan de la matrice, et un couvercle (43) formant un radôme de matière plastique comprenant, avec la structure de support de base, un joint coopérant d'étanchéité (52, 55) afin que le couvercle soit maintenu sur le support de base et entoure la matrice d'antenne, caractérisé en ce que la structure de support de base a une matrice de seconds piliers de support (35) destinés chacun à loger un goujon ou une vis (31) ayant un épaulement au contact d'une seconde ouverture correspondante de la matrice d'antenne, et en ce que chaque goujon ou vis a une tige (31a) dont la longueur est telle que, lorsque le goujon ou la tige est monté sur le second palier respectif de support, les éléments de la matrice soient retenus et alignés en direction perpendiculaire au plan de la matrice d'antenne.

2. Ensemble d'antenne selon la revendication 1, caractérisé en ce que la matrice d'antenne a une structure à trois plaques supportée entre deux plans de masse (13, 15).

3. Ensemble à antenne selon la revendication 2, caractérisé en ce que l'alimentation à trois plaques est placée sur un mince substrat diélectrique (11) maintenu à plat et parallèlement aux plans de masse par une matière diélectrique (12, 19) sous forme d'une mousse.

4. Antenne selon la revendication 3, caractérisée en ce que la matière diélectrique sous forme d'une mousse comprend, de chaque côté du substrat, une feuille diélectrique respective continue de mousse qui est souple et entoure de manière souple le substrat et le plan respectif de masse.

5. Ensemble à antenne selon l'une quelconque des revendications précédentes, caractérisé en ce que plusieurs troisièmes piliers (37) sont placés sur la structure de support de base de manière qu'ils supportent un réflecteur arrière (29) à une distance prédéterminée de la matrice d'antenne.

6. Ensemble à antenne selon la revendication 5, caractérisé en ce que le réflecteur arrière est en outre supporté par des épaulements formés sur les premiers et seconds piliers.

7. Ensemble à antenne selon l'une quelconque des revendications précédentes, caractérisé en ce que le dispositif périphérique d'étanchéité comprend une lèvre dirigée vers l'intérieur et destinée à être au contact d'un épaulement périphérique correspondant du support de base.

Fig.1.

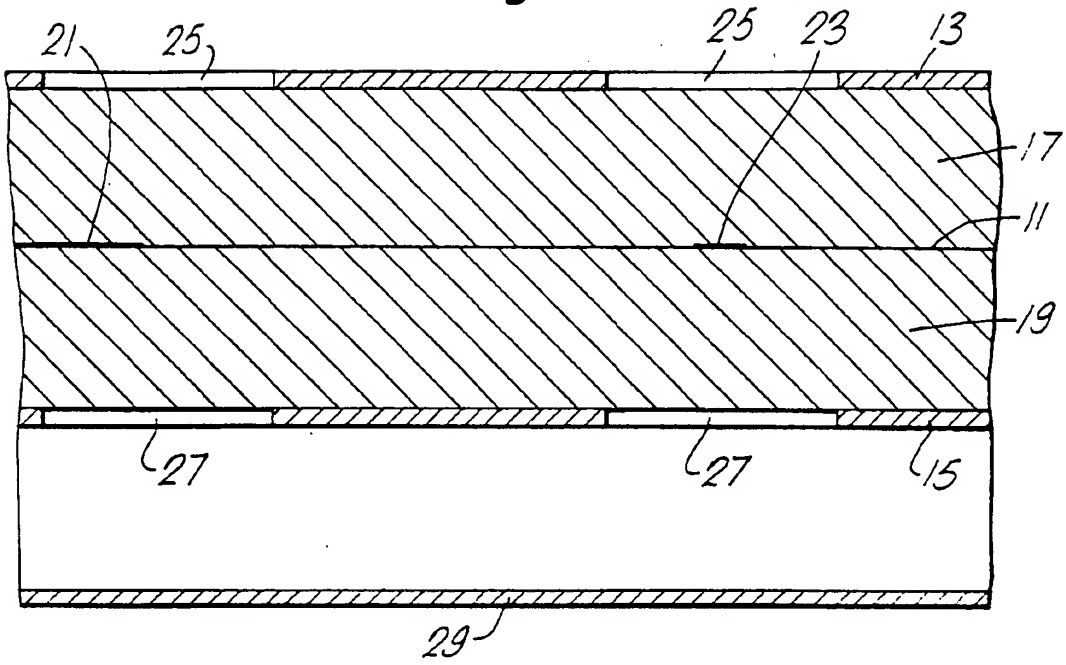

Fig.3.

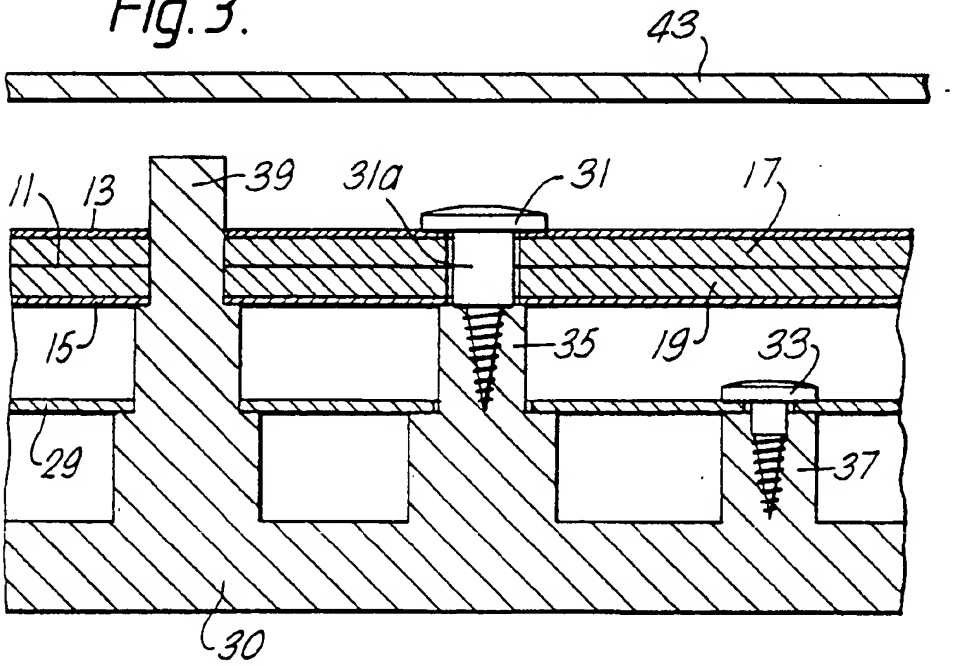

Fig.2.

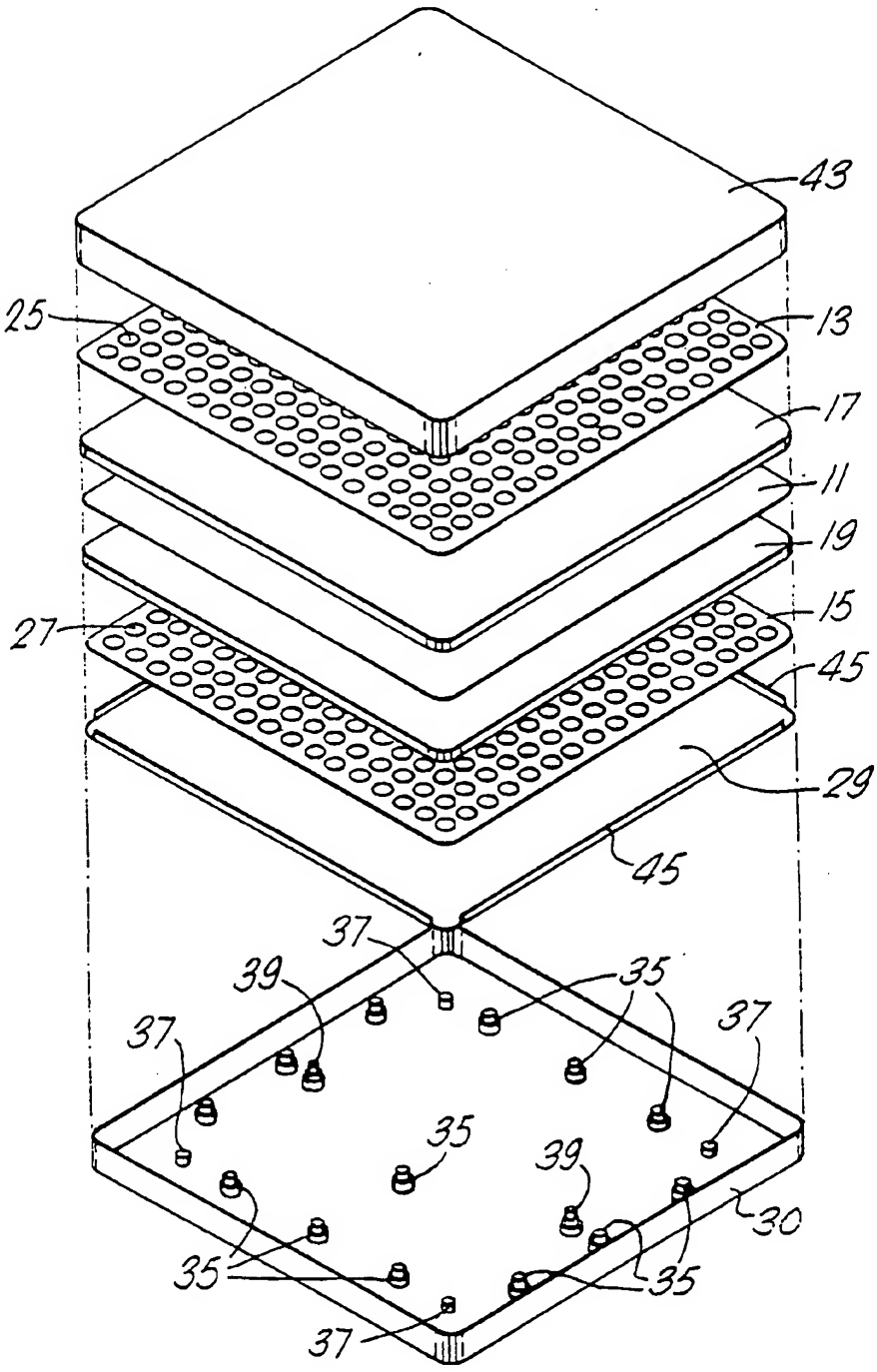

Fig.4.

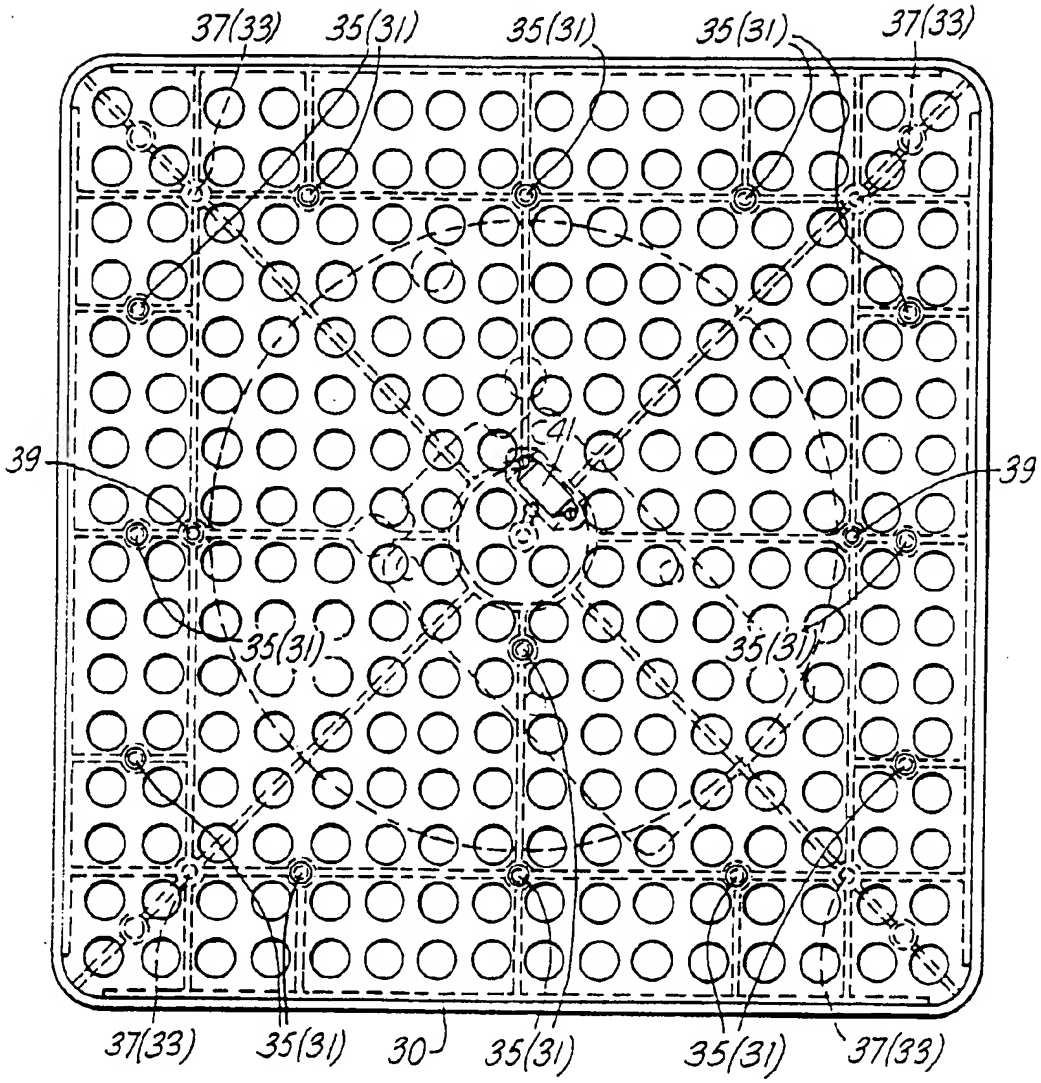

Fig. 5.

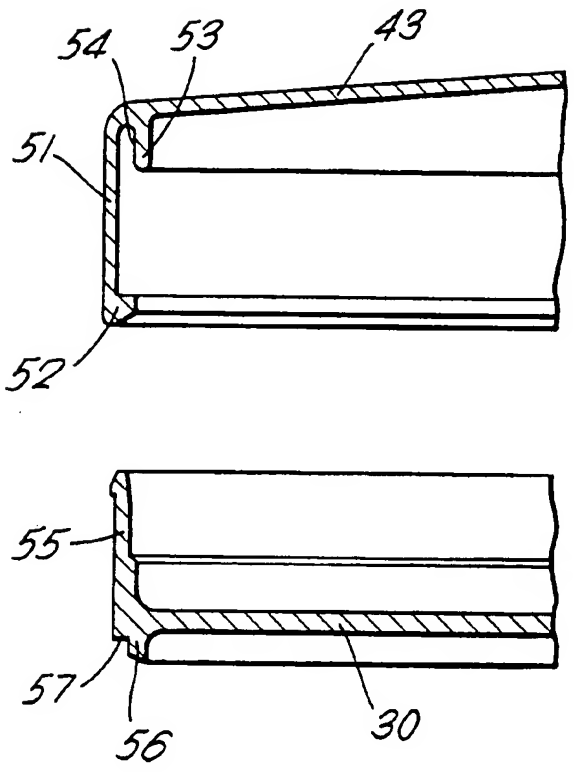

Fig. 6.